THE EXPLOSIVES ENGINEER

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Forerunner of Progress in Mining, Quarrying, Construction

The Republic of Venezuela, under the guidance of its president, His Excellency, Marcos Perez Jimenez, is vigorously pursuing a vast construction program. Now under way, or already completed, are new railroads, superhighways and secondary roads, dams, breakwaters, ports, and low-cost housing units.

One of the most recent projects is the construction of a multimillion-dollar dry dock at Puerto Cabello. The contract to remove a hill of rock overlying the area was awarded to a prominent construction firm known locally as Conticca.

Following consultations between Conticca officials and experienced explosives engineers as to the best method of blasting the variable rock formations, it was decided to use a series of tunnel or coyote blasts. The first blast in the series consisted of two tunnels driven alongside each other at plus 5.0 meters above sea level. Tunnel No. 1 had 30,366 cubic meters of solid rock embraced by its lateral wings; Tunnel No. 2 had 32,268 cubic meters bounded by its wings. A total of 107,500 lb. of dynamite was used in the twin-tunnel blast.

In the article, "Blasting Tunnels in Venezuela by Remote Control," beginning on page 7, the author describes the tunnel-driving procedures and the intricate electronic apparatus used in the remote control blast-firing circuit located five miles away from the blast.

* * *

The recent installation of a 78-mile section of a pipeline between Salem, West Virginia, and Claysville, Pennsylvania, completed the construction of a 1,200-mile natural gas pipeline extending from Louisiana's gulf coast to a central point in Pennsylvania's Washington County.

In some areas, the pipeline had to go up and down one hill after another, with some of the slopes approaching the vertical. In numerous places, trenches had to be excavated in hillside rock cliffs, small streams had to be crossed, and extra care exercised to avoid damaging already-existing pipelines along and across the right-of-way. The explosives used in clearing the right-of-way and in blasting the hard sandstone formation was Hercules® 40% Extra Gelatin.

Please turn to page 13.

* * *

To connect two main arteries in a sector occupied by the U. S. Army's 25th Infantry Division in South Korea, a 1½-mile roadway had to be built up a hillside rising more than 500 meters in less than ¼ mile. The roadway was cut through solid rock by 40 men from Company D, 65th Engineer Battalion, working two shifts over a four-month period. Every type of explosives known to the Engineer Corps was used on the project.

A summary of the construction of one of the steepest roads ever built in South Korea is given on page 19.

* * *

In our September-October and November-December, 1954, issues we presented Parts I and II of the article "Mining Uranium in the Colorado Plateau." These two installments described the weird beauty of the Plateau, the overall program of the Atomic Energy Commission and its guaranteed price setup, and the phenomenal success story of Charles Steen and his Utex mine.

In this issue, Part III, the final installment, beginning on page 20, describes the exploration activities in the Big Indian Wash and the Lisbon Valley, and the reopening of many old, abandoned mines. It also gives a resumé of the operations of two of the oldest mining companies working in the Four Corners area today: United States Vanadium Company and Vanadium Corporation of America. Brief comments on the fabulous story of Vernon Pick, an Eastern businessman who discovered uranium in the San Rafael Swell, are included in this final installment.

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EPA

VOL. 33 NO. 1 JANUARY-FEBRUARY, 1955

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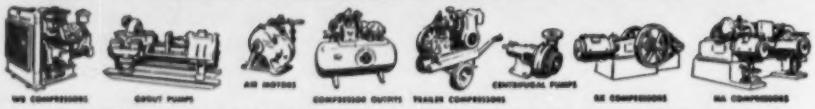

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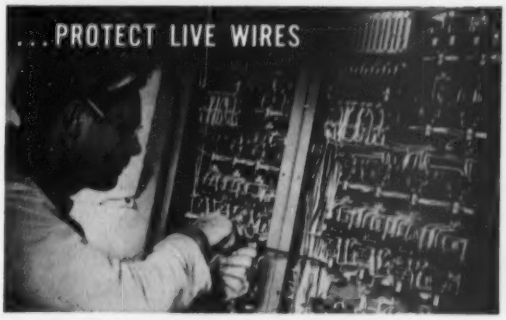

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HENRY DeWITT SMITH

Henry DeWitt Smith

PRESIDENT, AMERICAN INSTITUTE OF
MINING AND METALLURGICAL ENGINEERS

A Biography

THE recent induction of Henry DeWitt Smith as president of the American Institute of Mining and Metallurgical Engineers brings to that office an outstanding administrator with a background of fifty years of engineering and operating experiences in mines in the United States, Alaska, Canada, and South Africa.

DeWitt, as he is known to his friends, was born in Plantsville, Hartford County, Connecticut, the son of Charles Dwight and Lillian May (Hough) Smith. After completing the courses in grade and high schools in Hartford, he enrolled in the Sheffield Scientific School of Yale University and was graduated in 1908 with a Ph.B. degree. Two years later, he was awarded an E.M. degree by the university.

After graduating from college DeWitt went to work as a geological assistant with J. E. Spurr, Inc., where he gained valuable experience in mines in the Western States and Mexico. He was one of the last junior engineers trained by Joshua Edward Spurr.

In 1914, DeWitt went to Alaska as a foreman in Kennecott Copper Corporation's copper mine at Kennecott. During a three-year stay in Alaska, he was advanced to mine superintendent and assistant manager. Famous bonanza ore bodies were developed at Kennecott at that time. The profits realized from this development were the foundation of the growth and expansion of the corporation in the copper mining industry.

In 1917, he went to Jerome, Arizona, to become mine superintendent for United Verde Copper Company, and later became general superintendent at the mine. While with United Verde in Arizona, H. DeWitt Smith organized and directed a training school for young engineers in order to give them the benefit of his varied experience and to aid in developing and expanding their knowledge of underground mining activities.

Mr. Smith joined New York Trust Company as an engineer in its Industrial Department in 1924. His duties with the bank included the operation of a silk ribbon business and a milking machine company. He left the banking business in 1927, and for the next two years was sales manager for United Verde, with offices in New York City.

H. DeWitt Smith began his long association with Newmont Mining Corporation in 1930, as an engineer and a member of the board of directors. During World War II, he was loaned to the Government to take on the duties of adviser, vice president, and executive vice president of Metals Reserve Company, a subsidiary of the Reconstruction Finance Corporation. From 1941 to 1944, he was responsible for all domestic metals procurement activities. The soundness of the contracts arranged by Metals Reserve Company was proved after the end of the war when none had to be renegotiated.

Upon his return to Newmont, he resumed activities as a director. In January, 1947, he was elected a vice president of the corporation. Last September, he retired as a vice president but retained membership on the corporation's board of directors.

Mr. Smith joined AIME in 1911 and has been active in its proceedings for many years: a director during 1941-1942, chairman of the Nominating Committee in 1939, chairman of the Seeley W. Mudd Memorial Fund Committee, and vice chairman of the 75th Anniversary Committee.

During the past quarter century, H. DeWitt Smith has participated in many large copper property mergers, including Rhodesian Congo Border Concession, Ltd., and Bwana M'Kuba; Phelps Dodge-Calumet and Arizona; and the purchase of United Verde by Phelps-Dodge Corporation. At present, Mr. Smith is busy looking after Newmont's activities in South Africa.

Besides being a board member of Newmont Copper Corporation, he is managing director of O'okiep Copper Company, Ltd. He is also a director and a member of the executive committee of Phelps-Dodge Corporation and of St. Joseph Lead Company. In addition to membership in AIME, he is a member of the Mining and Metallurgical Society of America and of Sigma Xi honorary fraternity.

His clubs are Downtown Association, Mining, and University in New York, and Chevy Chase in Washington.

Henry DeWitt Smith married Ellen Dawson Burke in 1916, in Plainfield, New Jersey. They have one son and two daughters: C. DeWitt Smith, a mining engineer with St. Joseph Lead Company; Mrs. Alfred F. Sanford II; and Mrs. J. Clifton Rodes.

Besides his zest for finding and developing new high-grade ore bodies, DeWitt Smith's principal hobby is surf-casting for bluefish and striped bass off Nantucket beaches.

Editorial

"King-Size" Dynamite Cartridges

Explosives manufacturers are constantly on the alert to foresee changes in blasting practices and techniques, and to improve their products or develop new ones to meet such changes quickly and efficiently. Large staffs of technically trained men are maintained to carry on programs in research laboratories, at drawing boards, and in field tests.

An example of the results of such programs was the recent development and introduction of long-length, small-diameter "King-Size" cartridges of dynamite by Hercules Powder Company.

For some time, field representatives had reported an increasing use of long, or deep, blast holes in underground mines and quarries, and on heavy-construction work. The reports stated that, in many cases, the conventional 8-inch-length cartridges did not ride the contours of the long blast holes and frequent blocking of holes resulted. This caused loss of time in loading the explosives charges and increased operating costs.

Company researchers and design engineers combined their specialized knowledge and skills to produce a machine that packs dynamite into cartridges 12 inches, 16 inches, 20 inches, and 24 inches in length, with 1¼ to 2-inch diameters. The new packing machine, employing basic principles of hydraulic and pneumatic mechanization, and variable frequency control, is now in commercial production.

The King-Size cartridges have been enthusiastically received by explosives users. Some of the comments about the advantages they offer are:

1. They effect a continuous column of explosives, which contributes to more uniform fragmentation.

2. They minimize failures caused by a separation in the column of explosives in a blast hole.

3. They reduce the time and expense required to load explosives into the blast holes.

Construction in 1955

In a year-end review of the Nation's economy, Sinclair Weeks, Secretary of Commerce, said that the state of the economy, the foreseeable outlook, sound, progressive leadership by Government, and strong public confidence are among the reasons why we shall have a moderate upswing in business activity in 1955.

In 1954, new construction reached a record high of $37 billion. In addition, $15 billion was expended for maintenance and repair work. The overall dollar volume of $52 billion for the industry represented about 15 per cent of the gross national product. Current forecasts indicate that these figures will be topped in 1955.

President Eisenhower, in his State-of-the-Union message to the eighty-fourth Congress, proposed the biggest public works program ever contemplated in the history of the United States. It includes plans to bring the Nation's highways to modern standards in the next ten years, the construction of dams, schools, public housing units, and health facilities. To expedite the carrying out of this ambitious program the President has requested the Congress to provide funds to establish a coordinator of public works in the White House.

Construction is definitely in the forefront of economic activity.

Uranium

Centered in the Colorado Plateau, uranium mining activity stretches across thousands of square miles in Colorado, Utah, New Mexico, and Arizona. Augmenting this major area, there have been increasing interest and some active exploration in Wyoming, South Dakota, Montana, Nevada, and California.

Although uranium mining activity has been stimulated and sustained by the Government, through the Atomic Energy Commission, the recent spectacular growth is due, primarily, to the expanded activity of private industry.

In a recent report, Clinton P. Anderson, United States Senator from New Mexico, said: "We have witnessed in the past six years an impressive increase in domestic uranium ore production and the discovery of new deposits. This has been coupled with the development of improved exploration and ore-processing techniques. Completion of contemplated new mills and expansion of existing processing facilities now under way will permit full realization of the substantial gains which have been made. The domestic uranium industry is now firmly established and in a position to supply an ever-increasing proportion of our total uranium requirement."

NCSA Annual Convention

One of the features of the 38th annual convention of the National Crushed Stone Association, at Cincinnati, February 7 through 9, was the presentation of safety awards, sponsored by the association and THE EXPLOSIVES ENGINEER, to twenty-one quarries in recognition of their having operated an entire year (1953) without a lost-time accident.

The awards were presented to the winners by John J. Forbes, director of the U. S. Bureau of Mines.

We extend congratulations to the twenty-one winning quarries for their perfect records in eliminating accidents on the job, and to the National Crushed Stone Association for its long-time contribution to the promotion of safe working conditions among its member quarries.

THE BLAST: With the detonation of 107,500 lb. of dynamite loaded into 38 separate pockets in the two tunnels, a section of the big hill was blasted loose and the broken rock was rolled out in a cloud of dust and smoke.

TUNNEL BLASTING BY REMOTE CONTROL

Standing on the deck of a ship, Marcos Perez Jimenez, president of Venezuela, pressed a button and detonated 107,500 lb. of dynamite loaded into two tunnels 5 miles away

H. V. BRENNAN*

A COMPREHENSIVE program of heavy-construction projects has been under way for some time in the Republic of Venezuela under the active sponsorship and guidance of His Excellency, Marcos Perez Jimenez, president of the Republic. Many of the projects involving the construction of railroads, superhighways and secondary roads, dams, breakwaters, ports, and low-cost housing units have been completed in recent years, or are in the course of construction at this time.

One of the latest undertakings is the building of a multimillion-dollar dry dock at Puerto Cabello, including all appurtenances necessary for its use and maintenance. Work on this project is being done under the direction of the Ports and Airports Division of the Ministry of Public Works.

Obviously, a dry dock requires a foundation of great bearing strength and proximity to a navigable waterway. The location at Puerto Cabello was selected by engineers and officials of the Ministry of Public Works after thorough investigations. Geological data showed that three types of rock formations exist in the explored area: basic igneous rock, a granitiferous amphibolite; calcareous schist, a fine-grained rock containing calcite, quartz,

*Hercules Powder Company
Explosives Export Division
Caracas, Venezuela

mica, and some pyrite; and metamorphic limestone, a fine-to-medium-grained rock, intercalated in either the igneous rock or the calcareous schist.

The calcareous schist and the metamorphic limestone are found interstratificated, forming an inclined one-fold flank where the beds have a general N. 70 degrees E. strike and dip between 45 degrees and 60 degrees to the north. The basic igneous rock is found intruding into the series of calcareous schist and metamorphic limestone in the shape of lenticular masses or in thin sills.

One phase of the construction details at the Puerto Cabello dry-dock project, the removal of a hill of rock overlying the area, is described and illustrated in this article.

Removing Hill of Rock By Tunnel Blasts

The contract for removing this large volume of rock to plus 2.6 meters above sea level was awarded to Constructora Nacional de Tuneles y Carreteras C.A., a prominent organization of engineers and construction veterans known more familiarly as Conticca. On June 1, 1954, Conticca moved its men and equipment to the project site and preliminary work was started.

Before beginning any drilling and blasting activities, Conticca officials called in experienced explosives engineers for consultation and thorough review of the various methods of blasting the rock in the hill. It was decided that the quickest and most economical method to use was a series of tunnel or coyote blasts.

The first blast in the series consisted of two tunnels driven alongside each other at plus 5.0 meters above sea level. This was done to make sure that the rock formation beneath the area of the tunnel blasts would not be disturbed by the detonation of heavy charges of dynamite in the tunnels. Later, the floor was to be trimmed to plus 2.6 meters above sea level (the finished grade) by smaller, lighter blasts of explosives charges, using the wagon drill-hole method.

Establishing Working Faces

Before work on driving the two tunnels could be started, the west side of the hill of rock had to be excavated at two locations to establish working faces 10 meters high for the portals of the tunnels. This was done by firing successive blasts by the wagon drill-hole method. Vertical holes, 2½ in. in diameter, were drilled from the plus 15-meter line to the toe of the west slope. These holes were spaced 2.0 meters apart, each with a 1.2-meter burden. They were loaded with Hercomite® Bag-X powder. The charge in each hole was primed with one 1¼ by 8-in. cartridge of Gelamite® 1 dynamite and a Hercules® Electric Blasting Cap with 16-ft. leg wires. The explosives loading ratio averaged 1.2 lb. of dynamite per cubic meter of solid rock. The entire toe of the hillside in front of the tunnel area was blasted and removed in this manner.

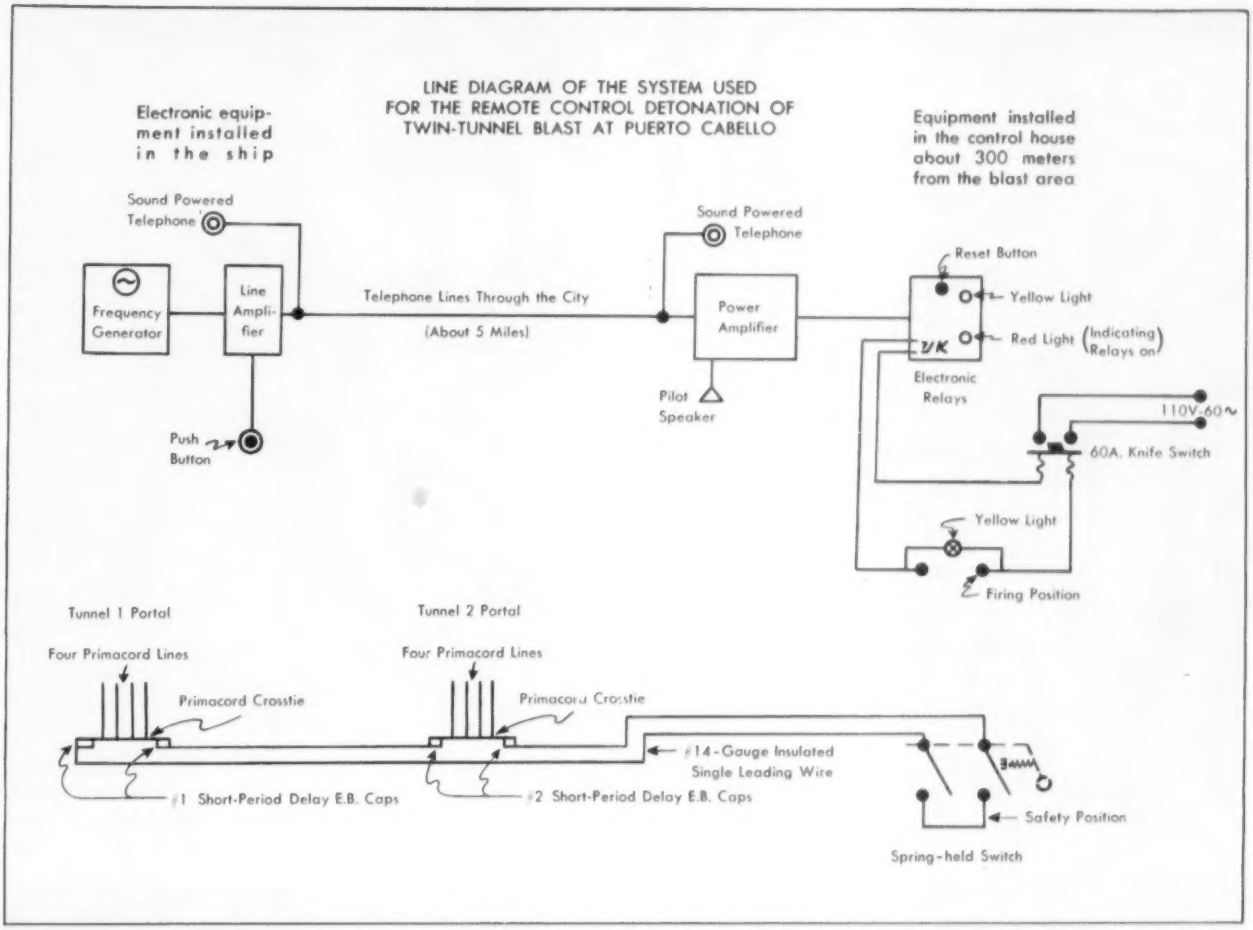
Tunnel Driving Procedures

The stems and lateral wings of the two tunnels were driven about 1.4 meters high and 1.2 meters wide. A tunnel round consisted of 11 holes 1½ in. in diameter driven 1.5 meters deep, using a Gardner-Denver air-leg compressed-air drill equipped with Crucible steel and Timken carbide-insert bits. Each hole was loaded with five 1¼ by 8-in. cartridges of Gelamite 1 and stemmed to the collar with moist clay tamping. The cap-and-fuse method was used to detonate the explosives charges, using Hercules No. 6 Blasting Caps and Beaver Brand Safety Fuse. Each blast averaged an advance of 1.1 meters. The rock encountered in driving the greater part of the tunnel stems and wings was the hard granitiferous amphibolite formation. After a round was blasted, the broken rock was handloaded into wheelbarrows and hauled to the outside of the tunnels.

Working three shifts every 24 hours, with 12 men on each shift, 40 consecutive days were required to complete the drilling, blasting, and excavating details of the two tunnels. In Tunnel No. 1, a total of 150 meters of tunnel was driven; in No. 2 Tunnel, a total of 151 meters of tunnel was driven. The rounds averaged an advance of 2.5 meters for each 8-hour shift, and 7.5 meters a day.

The loading of the dynamite charges in the tunnels began at 4:15 o'clock in the afternoon of Wednesday, September 29, 1954, and continued uninterruptedly until 11 a.m. on Tuesday, October 5, 1954, with both tunnels loaded almost simultaneously. The total elapsed time for loading the explosives and the stemming material was five days and eighteen hours. In each 8-hour shift, 18 men were employed to

REMOTE CONTROL BLASTING: When all electrical connections had been made aboard ship and on land, Venezuela's President Marcos Perez Jimenez pressed a button and detonated the explosives charges loaded into two rock tunnels 3 miles away. Standing behind His Excellency, Dr. Oto Curiel, chief engineer of the Division of Ports, listens on a telephone while Dr. Julio Bacalao Lara, minister of Public Works, watches for developments through binoculars.



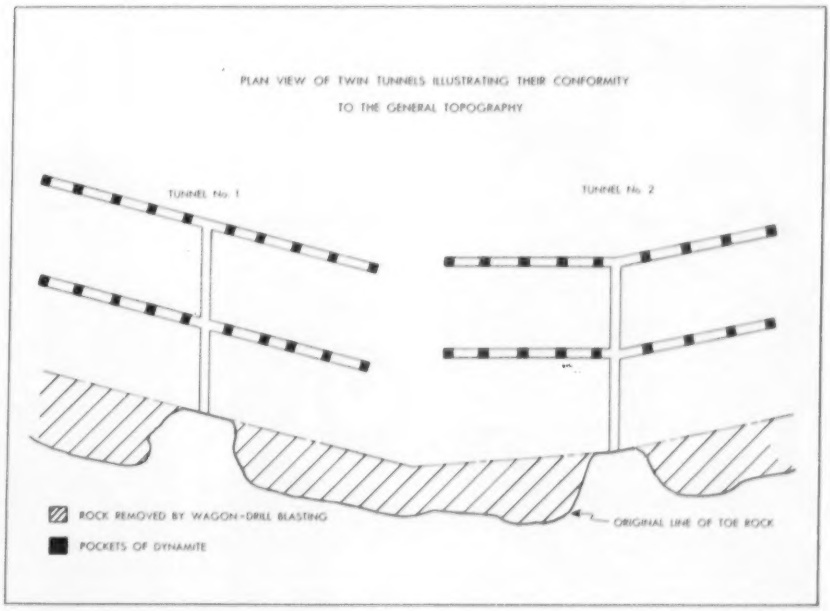
ELECTRONIC FIRING EQUIPMENT: This line diagram indicates the equipment installed on the ship and on land to detonate the Puerto Cabello tunnel blast by remote control.

handle the details of loading the charges and backfilling with stemming.

Tunnel No. 1

Tunnel No. 1 had approximately 30,366 cu. m. of solid rock embraced by its lateral wings. It was loaded with 52,500 lb. of dynamite, divided into 20 separate pockets, or charges, spaced about 6 meters apart in the lateral wings. There were ten pockets in the front wings and ten pockets in the rear wings. The dynamite charges were connected and detonated by means of four separate trunk lines of Plastic Reinforced Primacord.*

Two of the Primacord trunk lines were placed on the floor of the tunnel at each side of the lateral wings and the stem. Both trunk lines were covered with case-lining paper and an additional protective covering of clay. Reinforced Primacord cross-ties were


PLAN VIEW OF TWIN TUNNELS ILLUSTRATING THEIR CONFORMITY
TO THE GENERAL TOPOGRAPHY
TUNNEL No. 1
TUNNEL No. 2
ROCK REMOVED BY WAGON-DRILL BLASTING
POCKETS OF DYNAMITE
ORIGINAL LINE OF TOE ROCK

THE TWO-TUNNEL LAYOUT: This plan view of the two tunnels illustrates their conformity to the general topography of the area. The 38 black squares in the lateral wings show the location of the pockets in which the dynamite charges were loaded.

*Reg. U. S. Pat. Off. By The Ensign-Bickford Company

WAGON DRILL-HOLE BLASTING: Before the work of driving the tunnels was started, the sloping toe rock at the bottom of the hill in front of the tunnel area was removed by blasting with the wagon drill-hole method.

EXCAVATING TOE ROCK: A Northwest 80-D power shovel excavates blasted toe rock and loads it into Ford 10-cu. yd. tandem-drive dump trucks to establish working faces 10 meters high for the portals of Tunnel No. 1 and Tunnel No. 2.

CHECKING JOB PROGRESS: R. D. Antisdel, Conticca's managing director, at right, discusses job progress with his superintendent, Ted Hendricks, center, and J. H. Schindler, Jr., an explosives engineer, Hercules Powder Company.

TUNNEL ADVANCE: Blasting 11-hole drift rounds in the two tunnels averaged an advance of 1.1 meters per blast. The dimensions of the stems and lateral wings in both tunnels were approximately 1.4 meters in height and 1.2 meters in width.

made at 2-meter intervals throughout the wings and the stem. The charges of dynamite consisted of 8½-in. by 50-lb. cartridges of Hercomite-X stacked in place in the pockets somewhat like cordwood. The charge in each pocket was primed with two 50-lb. cases of Gelamite 1. Stemming, or backfilling material, consisted of dustless and stone-free red clay. This was packed solidly between all of the pockets and was extended through the stem to the portal of the tunnel.

Tunnel No. 2

Tunnel No. 2 had approximately 32,268 cu. m. of solid rock bounded by its wings. It was loaded with 55,000 lb. of dynamite divided among 18 separate pockets spaced about 6 meters apart in the wings, with nine pockets in the front wings and nine in the rear wings. Tunnel No. 2 was loaded, primed, and stemmed in the same manner as was Tunnel No. 1.

The layout of the stems and the lateral wings of the two tunnels and the locations of the individual pockets containing the explosives charges are illustrated in an accompanying plan view on page 9.

When the time arrived to fire the two-tunnel blast, two Hercules No. 1 Short-Period Delay Electric Blasting Caps were taped to opposite ends of a short piece of Reinforced Primacord which, in turn, was knotted to the four Plastic Reinforced Primacord trunk lines extending from the portal of Tunnel No. 1. Tunnel No. 2 was similarly primed with two Hercules No. 2 Short-Period Delay Electric Caps. The leg wires of the four caps were connected in series, using approximately 2,500 ft. of insulated No. 14-gauge single leading wire. The wire extended back to a bombproof shelter, a sheet steel-protected concrete block structure, which housed the intricate electronic apparatus used in the remote control blast-firing circuit.

Remote Control Firing Apparatus

A description of the remote control firing apparatus is given in a report by Dr. Edmundo J. Lopez O., an electrical engineer with the Ports Division of the Ministry of Public Works:

"From the diagram on page 9, it will be seen that a signal produced at the ship by a frequency generator (after being amplified) was transmitted through telephone lines to the bombproof control house in the valley near the blast area. When the push button installed in the plate circuit of the last two tubes of the line amplifier was pushed by the President of the Republic of Venezuela, an amplifier in the control house received and sent the signal to an electronic relay, which closed an electric contact 'K,' in series with a spring-held switch, a 60-amp. knife switch, a 110-volt 60-cycle source, and the electric blasting caps.

"A pilot speaker in the control house gave the 1,000 cycles tone when the signal came through, and immediately a yellow pilot lamp lit up on the electronic relay and on the spring-held switch cover, to indicate that contact 'K' was closed. With the 60-amp. knife switch closed and the spring switch already held closed in the firing position, the four electric caps were immediately detonated.

"During the entire operation, from the beginning to the exact moment of detonation, communication between the ship and the control house was maintained by means of sound-powered telephones, connected to the same telephone lines, thus giving, in that way, a positive check on the circuit at every instant. [Constant communication was likewise maintained by Conticca officials (using three portable Hallicrafter 'Little Phones') between the ship and the control house and between the control house and the spectators' observation point.]

Safety Precautions

"Various safety precautions were incorporated into the system: (1) The electronic relay cover was provided with a red and yellow pilot light, the red light indicating that the circuit was energized, and the yellow light indicating that contact 'K' was closed. (2) Another yellow pilot light in parallel with the first was on the cover of the spring switch to indicate that it was energized and was not to be touched until the scheduled time – 5 seconds before the blast. The spring switch was provided to prevent the premature firing of the blast due to accidental pressure of the button aboard the ship. When this switch was in the normal position it maintained the electric blasting caps in short circuit, to prevent accidental firing from stray currents. (3) The reset button on the electronic relay was provided to de-energize the relay 'K' after testing, thereby de-energizing the entire blasting circuit.

"The electronic relay was just a radio tube with sufficient negative bias to

READY FOR DYNAMITE CHARGES: A view of the portal of Tunnel No. 1 just before loading operations started. A D-8 Caterpillar is at work on a clean-up job in front of the area of the blast. The "No Fume" signs mean no smoking for the men on the job.

EXCELLENT RESULTS: Within 15 minutes after the blast, one of Conticca's Northwest power shovels was at work in the bank of broken rock, estimated at 170,000 cubic meters. The results obtained were gratifying to everyone associated with this unique blasting job.

prevent current flow in the anode circuit. The amplified signal being rectified entered the electronic relay cutting the bias and permitting the tube to conduct. The anode current passed through a relay which closed contact 'K,' thereby firing the blast.

"Besides all this, at the receiving-end amplifier, a filter was provided at the input, which attenuated the frequencies lower and higher than a tone of 1,000 cycles per second. The 1,000-cycle tone was chosen as the most convenient one in order to prevent any 60 c/s or 120 c/s induced currents from building up in the telephone lines (which were close to the power lines) and thus cause trouble.

"This remote control blasting was made possible by the cooperation received from the Puerto Cabello Telephone Company, whose lines were used for the operation. The electronic equipment consisted of standard Phillips apparatus, modified and adapted for this installation by Phillips Venezolana C.A."

On Saturday, October 9, 1954, at exactly 10:30 a.m. Venezuelan Standard Time, President Marcos Perez Jimenez of the Republic of Venezuela pressed a firing button on the corvette *Felipe Larrazabal*, anchored alongside the pier in Puerto Cabello about 5 miles from the blast site, and detonated 107,500 lb. of dynamite.

Excellent Results

The results of the blast were excellent. Estimates indicated that a total of 170,000 cu. m. of broken rock was realized. It was laid out in a sloping bank for easy shovel digging and loading. Vibrations were negligible; the Phillips' vibration machine in downtown Puerto Cabello recorded only a very slight tremor. The overall explosives ratio was about 0.63 lb. of dynamite per cubic meter of broken rock.

The firing of the blast signalized the official beginning of the Puerto Cabello dry-dock project.

In about fifteen minutes after the blast, and before President Jimenez and the group of officials from the boat at the pier could reach the scene of the blast, Conticca's shovels and trucks were at work in the big bank, excavating and hauling broken rock to the dump site.

During the writer's visit to the project, the principal equipment in use included three Gardner-Denver wagon drills, Model URUD99; twelve Gardner-Denver Jackhammers, or airlegs; two Gardner-Denver 500-c.f.m. compressors; one Northwest Model 80-D shovel with 2½-cu. yd. dipper; one Northwest Model 6 shovel with 1½-cu. yd. dipper; five Euclid dump trucks, Model 82FD, 11.1-cu. yd. capacity; five Ford rock dump trucks, Model T-800, tandem drive, 10-cu. yd. capacity; and two Caterpillar Model D-8 tractors.

The officials of the Ministry of Public Works who direct the construction operations on the Puerto Cabello dry-dock project are Dr. Julio Bacalao Lara, minister of Public Works; Dr. Carlos Carbonel, director of Ports and Airports; Dr. Oto Curiel, chief engineer of the Division of Ports; Dr. Orangel Abrue Mendez, director of Public Works in Puerto Cabello; and Dr. Rafael Pardo, resident engineer.

Officers and supervisory personnel of Conticca include Dr. Carlos Guinand Baldo, president; Russell D. Antisdel, managing director; Dr. Jose Medina, chief engineer; Ted R. Hendricks, superintendent at Puerto Cabello; and Dr. Federico Rivero, resident engineer.

CONSTRUCTING A SECTION OF A SUPERHIGHWAY PIPELINE

The skillful use of explosives and specialized equipment speeds the excavation of trenches in hillside rock cliffs and across the beds of streams

ELWOOD A. PAIS*

THE RECENT installation of a 78-mile natural gas pipeline from Salem, West Virginia, to Claysville, Pennsylvania, by Fulghum Contracting Corporation of Harrisburg, Pennsylvania, completed the construction of a 1,200-mile superhighway pipeline from the gulf coast of Louisiana to a central point in Pennsylvania's Washington County. The Fulghum contract was awarded by Manufacturers Light and Heat Company of Pittsburgh to provide more and better service for its 320,000 customers in Pennsylvania, Ohio, and West Virginia.

Manufacturers Light and Heat Company has a central delivery network of transmission and delivery lines and an underground storage field. Natural gas flows in from the south, the center, and the north through long-distance pipelines. From the north, it comes from the Tennessee Gas Transmission Company; from the center, the supplier is the Texas Eastern system; and from the south, from the new pipeline of the Gulf Interstate Gas Corporation.

Natural gas gathered in Louisiana by Gulf Interstate is delivered to United Fuel Gas Company at Kenova, West Virginia. The latter company, in turn, delivers gas to Manufacturers Light and Heat Company for its requirements through recently completed 20-in. and 24-in. pipelines. Originally, the contract for the construction of these two pipelines was awarded to the Britton Contracting

*Hercules Powder Company
Pittsburgh 22, Pa.

UP AND DOWN HILLS: In laying the pipeline at several locations, trenches had to be excavated in hillside rock cliffs, with some of the slopes approaching the vertical. Numerous small streams were crossed. At times, Fulghum crews had to slow down operations to prevent damage to existing pipelines that ran along and across the right-of-way.

STARTING A SECTION: As work got under way on a 12-mile section of pipeline, the photographer took a picture of some of the specialized equipment used in the excavation of a trench in variable terrain.

Company of Harrisburg. Later, with the acquisition of the Britton company's interest, the Fulghum organization took over the contract and completed the two sections.

The contract involved the construction of 35 miles of 24-in. pipeline from the Lanham station of United Fuel Gas Company near Charleston, West Virginia, to Limestone and Nigger Hills in Jackson County, West Virginia, for the storage of natural gas coming from Gulf Interstate's recently completed 845-mile line of 30-in. pipe.

After the 30-in. section was completed, the Fulghum company contracted to build 20 miles of 20-in. pipeline. This project completed the natural gas line from United Fuel Gas Company's Cobb station to the Manufacturers Light and Heat Company's pipeline near Nicut, Calhoun County, West Virginia.

DRILLING BLAST HOLES: Holes for blasting hard, yellow sandstone encountered on the Fulghum contract were drilled on 3-ft. centers and staggered from 2 ft. to 6 ft. deep. Blasting results were consistently excellent.

Difficult Terrain

The laying of pipelines in some parts of West Virginia is exceedingly difficult. At the Lanham station end of the 24-in. line and for almost the entire 20 miles of the 20-in. section between the towns of Spencer and Nicut in West Virginia, the pipelines had to go up and down one hill after another, with some of the slopes approaching the vertical. Trenches had to be excavated in hillside rock cliffs, numerous small streams had to be crossed, and operations were slowed down at some locations to prevent damage to existing pipelines which ran along and across the right-of-way. Explosives were used extensively in clearing the right-of-way and in blasting hard sandstone in some areas of the trench line. Excellent blasting results were obtained with the use of 40% Extra Gelatin dynamite. The explosives charges were detonated by the cap-and-fuse method. Primacord* was used in wet places and in some of the more difficult terrain. Despite the obstacles encountered the work was finished in good time.

The 78-mile Project

Upon completion of the two sections for United Fuel Gas Company, the Fulghum company's "spread" was moved to Claysville, Pennsylvania, to complete the northern end of the Manufacturers Light and Heat Company's 78 miles of 16-in., 20-in., and 26-in. pipeline started this past summer under the supervision of Edward Flanagan and John G. Wells.

*Reg. U. S. Pat. Off. by The Ensign-Bickford Co.

ON A HILLSIDE: A ¾-cu. yd. backhoe was used to excavate the trench on a hillside. The backhoe was held in place by a cable connected to a D-8 dozer stationed above on the slope.

In the language of pipeline contractors, a spread is a unit of measure of men and equipment. Each spread must have a complete construction setup, representing an investment from $500,000 to more than $1 million in specialized equipment and materials. In the field, a spread is strung out along a pipeline job for about 10 miles, from the right-of-way crew up front to the backfill and cleanup crews at the rear.

In planning and constructing the 78-mile pipeline contract, the Fulghum organization followed the usual procedure for such work:

1. A preliminary survey of the area was made by aerial photography, and the resulting mosaic was studied by engineers who selected the best general routing for the line.

2. A detailed field survey of the terrain was made by civil engineers.

3. Before construction work began, the right-of-way was procured.

4. Preparing the right-of-way required the clearing and grading of a roadway about 50 ft. wide along the entire length of the pipeline.

5. As the right-of-way crew progressed another crew began stringing pipe alongside the ditch line. The pipe, when received from the mill, was stockpiled at points most accessible to the right-of-way.

6. As the pipe-stringing crew advanced, other sections of the spread started work in the following order:

a. The ditch crew prepared the trench in which the pipe was to be buried.

b. The bending crew bent the pipe to exactly fit the bed of the trench.

c. The pipe crew put the sections of pipe together and welded each joint with a stringer bead.

d. The welding crew finished welding the separate lengths of pipe into a continuous pipe.

e. The dope crew cleaned the pipe of all scale and rust and applied a primer coat of enamel, followed by a coating of tarlike bitumen and one or more protective coatings of wrapping materials.

f. The lower-in crew placed the pipe in the bed of the trench without damaging the wrapping.

g. The backfill and cleanup crews filled in the trench, leveled the right-

WET GOING: In water holes and in places where the trench had caved in, clamshells were employed. These versatile units were also used for excavation along the trench line on some steep hillside locations.

of-way, terraced where necessary, and restored fences and roads.

Blasting Hard Sandstone

The bed of the trench, or ditch, for the 26-in. pipeline was approximately 4 ft. wide and 5 ft. deep. Excavation was done with a Model 320 Cleveland trenching machine, except where rock was encountered. When rock was present, all dirt was removed before the drilling and blasting crew moved in. On this job, the rock encountered along the line was a hard, yellow sandstone formation.

Equipment for the drilling and blasting crew included a D-6 Caterpillar dozer towing a 600 Gyro-Flo rotary Mobil-air Ingersoll-Rand compressor, on which two Model 99 Gardner-Denver wagon drills were fastened to an H frame suspended from the side boom. Holes for blasting were drilled on 3 ft. centers and staggered from 2

WHEEL-TYPE DITCHER: Where material other than rock was present along the trench line, the excavating details were accomplished with a Model 320 Cleveland trenching machine.

BREAKERS: After pipe was buried in hillside trenches, burlap bags filled with earth were used to build breakers in the trench from bottom to top to eliminate the possibility of washing and caving.

BENDING PIPE: A D-8 dozer hauled the bending machine along the line to places where sections of pipe had to be bent to fit the bed of the trench. A crane on the dozer took care of pipe-handling details.

ft. to 6 ft. deep, depending on the depth of rock to be excavated. The drills were equipped with 1¾-in.-diameter steel and 2-in. bits. Hercules® 40% Extra Gelatin dynamite, packed in 1¼ by 8-in. cartridges, was used throughout the job. Each loaded charge was primed with a Hercules® No. 6 Blasting Cap and Orange Wax Charter Oak fuse. Primacord was used in wet places and, occasionally, in difficult terrain. Results from the blasts were consistently satisfactory. Mile after mile of ditch was excavated in rock sections without requiring any secondary blasting.

In areas where there were no rock formations, a Model 320 Cleveland trenching machine took care of the excavation, making up to 4,200 ft. of trench in a ten-hour workday. After blasting rock sections, a Unit ¾-cu. yd. backhoe and a Model 85 Link-Belt speeder with a ¾-cu. yd. backhoe were used. In water holes or where the trench had caved in, clamshells were employed. Clamshells were also used for excavation on steep hillsides.

STRINGING PIPE: Trucks loaded with pipe were hauled up hills along the right-of-way by a D-7 dozer with side boom attachment for placement of the pipe beside the trench.

Burying the Pipe

In laying the line, the pipe-stringing crew placed the pipe along the trench behind the trenching machine. Following the stringers, the pipe-bending crew, equipped with a Crutcher-Rolfs-Cummings vertical machine, bent the 26-in. pipe to fit the bed of the trench. A Model D-8 Cat dozer was used to

lift and place the pipe onto the bending machine, and to move the bending machine as job progress required.

The welders with two tandem (GMC) 3-ton trucks with metal beds worked behind the bending crew. Each truck was equipped with two Lincoln electric welders of 300-amp. capacity. An M. J. Cross inside clamp was used to line up each section of 26-in. pipe for the bead weld, known as the first pass. (Each pipe section was 40 ft. long and weighed one ton.) This was followed by a second weld called the hot pass which reinforced the first weld. After this was done, the back-end welders put in the filler weld and cap weld which joined each section of pipe into a continuous pipeline. The welded joints were x-rayed for defects and the line tested under pressure before it was buried in the trench.

Before burying the pipe, all mill scale, rust, dirt, and any other foreign matter was cleaned off with a Crutcher - Rolfs - Cummings machine, and a coat of quick-drying enamel applied. Following this operation, another machine applied a protective coat of tar and two spiral wrappings of felt wrapper. These protective measures were taken to keep the pipe dry and free from corrosion, thus adding long and useful life to the pipeline.

The lowering of the pipe into the trench was done with special care so that the wrapping was not damaged. Model D-8 dozers equipped with Trackson pipe-layer side booms were used for this work. In rocky areas it was sometimes necessary to pad the bottom of the trench with earth and to wrap the pipe with 4 by 9-ft. sheets of rock shield to prevent the rock from penetrating the external coating of the pipe. On hillsides, after the pipe was in place, burlap bags filled with earth were used to build breakers in the trench from the bottom to the top to prevent washing and caving. Usually the number of breakers needed was determined by the steepness of the hill and the type of soil encountered.

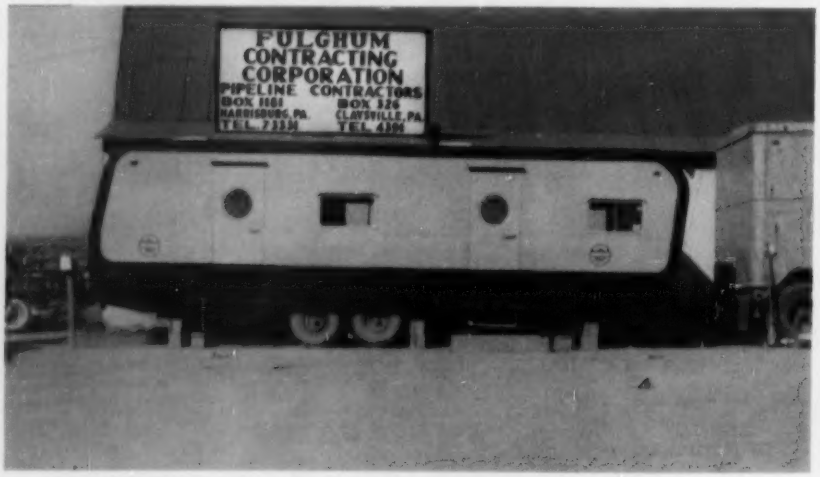
The final phase of the work on the line was handled by the backfilling and cleanup crews. Using Model D-6 and D-7 dozers, the trench was filled and leveled to conform with the original contour of the land. On hillsides or slopes of any degree, the line of the trench was terraced to prevent soil erosion. All roads and fences were restored to their original condition and to the satisfaction of the property owners along the right-of-way.

COVERING PIPE: After tarlike bitumen was applied to the pipe, it was wrapped with two coverings of felt material. These covering applications protect the pipe from corrosive effects of the elements and add years of uninterrupted use to the line.

As the various pieces of equipment worked their way out at the end of the pipeline in Pennsylvania, they were moved to the Fulghum Contracting Corporation's shop at Claysville, given a general overhauling and a new coat of paint, and made ready for transfer to the next location.

The officers and directors of operations of Fulghum Contracting Corporation include J. T. Fulghum, president; W. P. Fulghum, vice president; M. M. Shelley, secretary-treasurer; and W. E. Stainback, general superintendent. Office managers on the Claysville project were George R. Fleming and Frank G. Hindman.

The superintendent of pipeline construction for Manufacturers Light and Heat Company is W. D. "Hank" Burdette. The company's chief inspectors on the Fulghum contract were "Red" Goodin, Willis Guthrie, and Bill Long.



FIELD OFFICE: A trailer with special equipment and accessories served as the field office for Fulghum's supervisory personnel on various pipeline projects.

BLASTING: Heavy rock cuts were blasted with everything available, including shaped charges of composition C-3 to TNT and dynamite.

Army Engineers Blast a Roadway up a Hillside in South Korea

Forty men from Company D, 65th Engineer Battalion, cut through solid rock and conglomerate to construct a roadway up a hillside rising more than 500 meters in less than a quarter of a mile

LIEUTENANT THOMAS BYRNE*

DESPITE the many problems involved in blasting solid rock and clearing debris from a rugged hillside rising over 500 meters in less than a ¼ mile, the men of the 2nd Platoon of Company D, 65th Engineer Battalion, constructed one of the steepest, curviest roads ever built in South Korea.

But, in the words of Lieutenant Frederick Perles, whose platoon made the road possible, "It was just routine Engineer work."

Although the roadway is only about 1½ miles long from end to end, it had to be built up the side of a hill 600 meters high. Forty men from Company D's 2nd Platoon worked two shifts, when weather conditions permitted. One crew started at 4 a.m. and worked until noon; another took over at 12:30 p.m. and continued operations until 8:00 p.m. Except when held up by washouts or rain, the men worked seven days a week.

Variety of Explosives

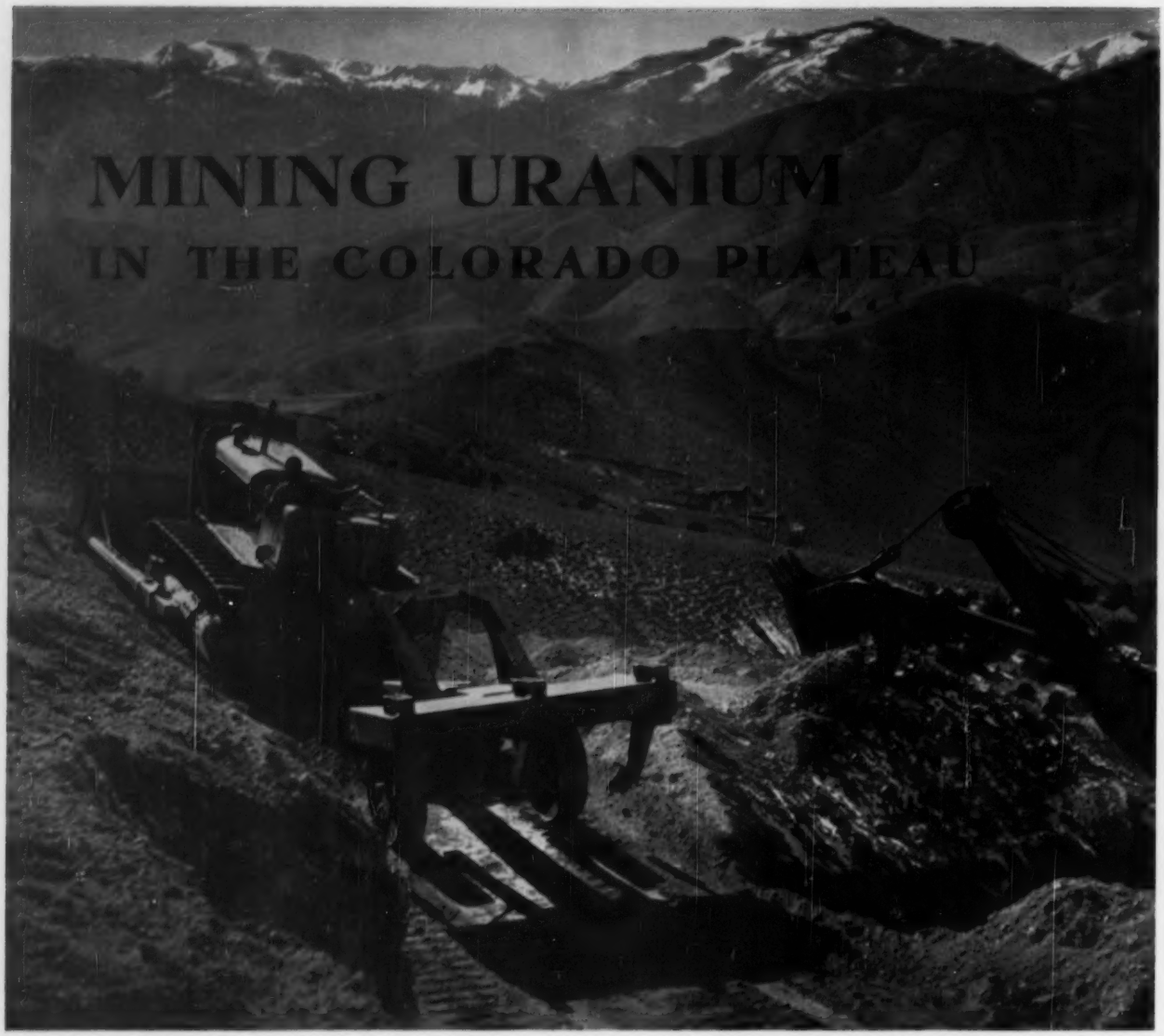
"Practically every type of explosives known to the Engineer Corps was used on this project," Lieutenant Perles said. The Yuma, Arizona, officer added, "Everything from 15- and 40-lb. shaped charges of composition C-3 and cratering charges to dynamite and TNT was put to use to break loose many tons of solid rock and conglomerate to make the road passable."

The men worked with three bulldozers; consumption of high explosives was about 2,000 lb. a week; and it took about four months to construct the road, which connects two main arteries in the 25th Infantry Division sector. Some of the blasts contained more than 400 lb. of explosives. The danger of misfires was always present because of the dampness of the area. Washouts and rock slides often filled in the road at night, making it necessary for the crew to clear the right-of-way with a bulldozer to the location where work had stopped the night before. After blasting most of the day, the men had to repeat the road-clearing performance in order to get off the hill at night.

Some of the natives claim that the traditional engineer cry of "fire in the hole," indicating that a blast was about to be set off, can still be heard reverberating off the green hills as the men of the Tropic Lightning Division's 65th Engineer Battalion write the word *finished* to another "routine job."

CLEARING THE ROADWAY: Army Engineers, working with bulldozers, were kept busy clearing the hillside of blasted rock and debris from slides and washouts. Except when held up by washouts or rain, the GI roadbuilders worked on a two-shift, seven days a week basis over a period of about four months.

*APO 25
San Francisco, Calif.



UNCOVERING URANIUM: After stripping the overburden covering uranium ore bodies, Bullion Mining Company will quarry a deposit of uraninite near Marysvale, Utah. Pitchblende is also being developed in these areas by Vanadium Corporation of America.

EXPLORATION ACTIVITIES RIVAL THE FABULOUS GOLD-RUSH DAYS

CHARLES F. THOMAS*

PART III — CONCLUSION

The big Indian Wash and the Lisbon Valley to the north and east of the Steen holdings are being explored extensively by many companies. In the valley three miles north of the Steen development, the Cal-Uranium Company of Moab has driven a shaft 300 ft. deep to the Chinle formation. Other exploration and mining work are being done at numerous locations along the 50-mile-long valley with its many canyons, gulches, and ridges.

The Homestake Mining Company of Lead, South Dakota, fame has owned a group of claims on the slopes of Lisbon Valley for several years and is carrying on an extensive program of mining and development work.

Lisbon Uranium, a company acquired by Floyd Odlum's Atlas Corporation, is comparatively new in the program of development of the Lisbon Valley. Intensive exploration of a sizable block of claims is now under way. Some of the claims being explored are reported to have been purchased from Charles Steen.

Many drill rigs are kept busy putting

*P. O. Box 1017
Ephrata, Washington

down test holes at many locations throughout the valley. Pay ore is expected to be encountered at depths up to 600 ft. With the exception of the pitchblende seams in the Marysvale and the Henry Mountain areas, all the uranium occurs in blanket formations.

Paradox Valley, in Colorado, west of Naturita, is one of the unusual geological occurrences of the region first recognized by Father Escalante in 1776. The valley, about 3 miles wide, situated between massive cliffs of red sandstone and bounded by 13,000-ft. peaks of the La Sals to the west, is marked by an anticlinal ridge extending from east to west. Through some strange freak of nature, the Dolores River crosses the valley and the ridge of the anticline at a right angle, entering the valley from the south through a narrow and sharply grooved canyon and leaving it at the northern side by another deep canyon.

Old Mines Reopened

Between Paradox Valley and Naturita, exposures of the Morrison formation may be observed in many places along the pinon-covered slopes of the ragged hills paralleling the long lonesome road. At dozens of places along the escarpment are the openings of old mines and the dumps abandoned many years ago when the demand for vanadium lessened. Today, many of these mines are being reopened. Even the waste on the dumps, carelessly spilled near the portals, is being searched for uranium.

About 15 miles east of Paradox, a traveler may turn sharply to the right and proceed in a series of twisting switchbacks to a dozen mines and prospects scattered along the north slope of Monogram Mesa. To the east of the branch road, the Climax Uranium Company of Grand Junction has commenced an extensive development to supplement some of its already-producing mines in that section. On a rocky point reached by a steep, winding road, the company is sinking a 5 by 10-ft. two-compartment shaft to reach carnotite lying from 220 to 250 ft. below. Work on the shaft began on March 17, 1954. It is presumed that by the time this story is published production will be well under way. Preliminary studies made from test holes indicate that the ore beds are of unusual thickness and high in uranium content. Other claims belonging to this company are being worked from drifts. The ore is dumped into chutes from where it is transferred to automobile trucks for shipment to the mills.

The Atomic Energy Commission maintains an engineering camp near the site, which houses crews making studies over the Mesa area. Travelers often find AEC and USGS camps over the four states. Most of the shelters are trailer houses which may be readily shifted should the need arise. Office buildings and cookshacks are usually constructed of wood, built so they can be quickly dismantled and reerected at another location.

Two of the oldest mining companies working in the field today are United States Vanadium Company and Vanadium Corporation of America.

United States Vanadium Company

United States Vanadium Company has produced uranium and vanadium mined from deposits adjacent to its mill at Uravan, Colorado, for many years. The mill and the attractive little town housing the company's employes lie in a colorful canyon on the San Miguel River, which rises in the high San Juan peaks 60 miles to the east. A plant originally constructed at Uravan many years ago by Standard Chemical Company, and used in the recovery of radium, was rebuilt in 1936. During and since World War II, it has occupied an active place in uranium recovery. Following the discovery near Rifle, Colorado, of the largest deposit of vanadium ore ever found in America, the company constructed a large recovery plant at that location. This plant was idled in 1932 but is again active in the treatment of uranium ores shipped to it.

The Uravan mill extracts uranium and vanadium. In their recovery, chemical reagents are added and the ore is discharged into huge roasters. After the roasting operation, the solutions are leached in large wooden tanks and dissolved by chemical solutions. Following further treatment, the minerals are precipitated and passed through filter presses where they are separated and prepared for shipment.

USV, as the company is known throughout the area, owns mines in many counties in Colorado and Utah. Many of its claims lie within the Uravan Mineral Belt, an area varying from a mile to 40 miles in width and about 90 miles in length. The company has about 50 active agreements with mining contractors for mining on its properties under a contract arrangement. The company also purchases ore from approximately 90 other independent producers working other claims.

Generous contracting terms tend to make the plan attractive to miners. They are guided in their work by com-

CAL-URANIUM MINE: The headframe and camp buildings of the Cal-Uranium mine are located 5 miles north of Steen's Utex mine. The shaft is approximately 400 ft. deep.

pany engineers, who see to it that all ores of commercial value are recovered. Because of the irregularity of the deposits of carnotite ore in the Morrison formation, where most of the mining is done, the miners follow the old adage "stay with the ore," and work as much as possible in pay ore. The ore, lying in a blanket formation, is usually soft and is easily mined. It varies in thickness from a foot to as much as 10 ft. or more. Fossil remains of trees and vegetation are common and occasionally petrified logs or branches are found. Contractors are allowed to use the type of equipment that fits the deposit. Haulage of ores from the mine to the loading platforms or chutes is done often with wheelbarrows, a method well adapted to the irregularity of the measures and one which requires only a small investment. Other mines use small ore cars, pushed or pulled on light steel rails.

In the company operations more modern equipment is used. Jackhammers and jacklegs are used for drilling holes for blasting. Blasting is done with 25 and 40 per cent dynamites in standard-size cartridges. Various types of compressors, ranging from 105 to 600-cu. ft. capacity, are used to supply air to the equipment. Water is used with all drilling activities underground.

Scrapers, operated with double-drum air-driven hoists, load much of the ore. Mining operations by USV are worked through 50 to 60 incline shafts, vertical shafts, or drift shafts located at different points over their operations. Ventilation is provided by means of forced and natural ventilation, and all Federal and State mining regulations are observed.

LISBON VALLEY: A look at Lisbon Valley in the Big Indian Wash region from a high point two miles north of the Utex mine. This area is being extensively explored.

AT MONOGRAM MESA: This is the headframe and equipment of Climax Uranium Company on the slope of Monogram Mesa. At this location, carnotite ores are found at a depth of 225 ft.

Accent on Safety

Safety is stressed by USV. Employes of the company's mining department have worked since June 7, 1952, with but one lost-time accident. Considering the type of work being done and the conditions under which the men have worked, this is an unusual record. The company employs a safety engineer who provides safety instruction, lectures, and motion pictures for all employes and their families. Special instructions in safety are also given the youngsters who live in the little village, which houses about 800 people. Another special feature in USV's safety program is supplying safety goggles to all employes without charge. If a special prescription is required, a small fee of $5 is charged for the glasses. Employes enjoy vacations with pay ranging from one to four weeks, depending upon the length of employment. Employes also receive other benefits, such as the opportunity to participate in a low-cost health-and-accident-insurance plan, a savings plan to which the company makes substantial contributions, and a pension plan which provides regular benefits on retirement.

United States Vanadium Company is a Division of Union Carbide and Carbon Corporation. Its western headquarters are at Grand Junction, Colorado. Colorado personnel of the company includes A. Q. Lundquist, general superintendent, Grand Junction; E. M. Paris, manager of mines, Grand Junction; J. F. Brenton, superintendent of plants, Grand Junction; J. L. Lake, chief metallurgist, Grand Junction;

R. D. Van Zante, plant superintendent, Uravan; and H. C. Peterson, plant superintendent, Rifle.

Vanadium Corporation of America

Vanadium Corporation of America's field offices are located at Durango, Colorado. In 1948, in this picturesque old mining and smelter town, famous in the early history of Colorado, the corporation acquired, and has since operated, an old smelter. This unit was used for many years to smelt ores mined in the San Juan district. During World War II it processed most of the uranium used in the making of A-bombs. During those days many trucks rolled in with ore and the refined product was quietly moved away. Many wondered what was being produced. The mill has been repaired and is now back in service, processing the ore which is hauled to it from all over the Colorado Plateau.

The Vanadium Corporation owns more than 500 claims throughout Colorado, New Mexico, and Utah, and is developing a large pitchblende mine at Marysvale, Utah. It also operates 50 or more mines with from 2 to 50 men employed at the different locations. The largest operation being developed by the company at present is called Monument No. 2, a property in northeastern Arizona. Large deposits of uraninite have been found in the Shinarump formation, a measure in the upper Triassic. Some underground mining is being done and extensive stripping operations are under way. It is planned to begin quarry work as quickly as possible. The Shinarump formation is covered with an overburden of approximately 18 ft. of dense sandstone of the Chinle formation. The claims lay in the Navajo Indian Reservation and most of the employes are Navajos. They live in crude huts scattered over the treeless, rocky hillsides, or in the typical desert hogans of the Navajo, remote from the camp. No water is available near the camp except that hauled by tank truck from a well 5 miles away and distributed into barrels and tubs for the convenience of the miners and their families. Some water is stored for mining use in a large tank near the mine location.

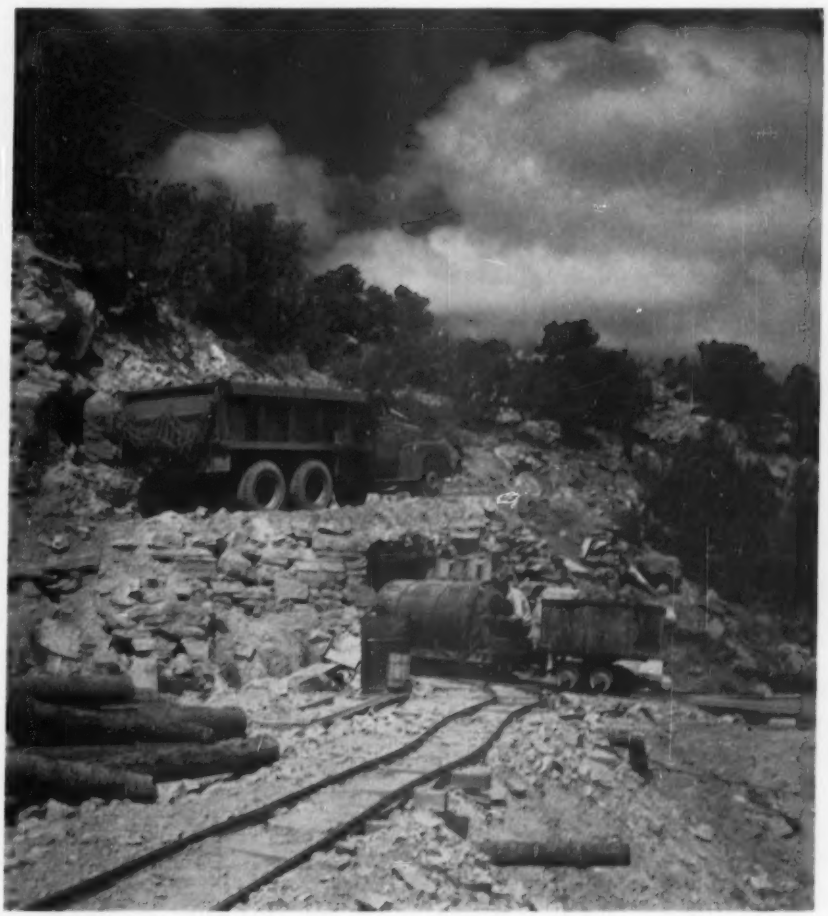
The Shinarump formation is also a sandstone varying from 20 to 30 ft. in thickness. The deposit, a secondary ore, is grayish in color and is easily drilled and broken. Most of the ore produced is hauled to Durango, more than 120 miles away, over a rocky road that is little more than a trail in many places. The Monument No. 2 property is located on the San Juan River, about 30 miles east of Mexican Hat.

The corporation's mine at Marysvale, Utah, is located on the Freedom No. 5 claim. Uranium is found in the pitchblende occurring in two major fissure seams which are nearly vertical and vary from 1 to 18 ft. in thickness. The mine is being developed through a large three-compartment shaft which has been sunk to a depth of 500 ft. Six levels have been opened from the shaft and one level has a cross cut 2,200 ft. long. Some of the ore runs as high as 2 per cent uranium. Pitchblende, a primary ore, requires different milling treatment from carnotite or other secondary ores and will be shipped to the smelter at Salt Lake City for treatment. Currently, all the ore mined is being stock-piled for future shipment.

Other mining activities of the company are located at widely scattered points over the plateau. Most of the operations are in small, yet highly productive, mines located in the Morrison formation.

Durango, the western headquarters of Vanadium Corporation of America, is located in the southwestern part of Colorado on the Colorado & Southern Railroad, one of the last of the narrow-gauge railways in the nation.

W. C. Keeley is president of Vanadium Corporation of America. D. W. Viles, or "Denny," as he is known throughout the West, is vice president in charge of mining and milling, with headquarters at Durango. In addition to mining properties in the Colorado Plateau, the corporation has extensive



MINE PORTAL: A small compressed-air locomotive is seen pushing a car loaded with ore out of a uranium mine portal in one of the many hundreds of hills in the Colorado Plateau.

WATER SUPPLIES BY TRUCK: Because of the absence of water in the region, workers are supplied by a tank truck which delivers it from a well 5 miles away to barrels and tubs.

vanadium holdings in Peru, Southern Rhodesia, and Canada.

West of Moab

West of Moab and Monticello, between the Colorado River and against the Wasatch Mountain range, is a wide area more inaccessible than any in the Naturita or Moab regions. But luck and Geiger counters have brought almost as much activity in uranium mining in this area as there is east of the Colorado River. Temple Mountain, The Reef, San Rafael Swell, Hite, Dead Horse Point, and the Henry Mountains are names of localities that occur in the many discussions which arise concerning the discoveries of uranium. The areas are more easily reached from the north over an old graded but recently graveled road branching south from Highway 50, a few miles west of Greenriver, Utah. All travelers entering the region are warned to carry plenty of food, water, and gas. From the West, a half-dozen trails approach the broken canyons and intercept the north to south road at wide intervals. Through the summer months, the mountain streams are rivers in name only, except when some cloudburst hits the desert land and pushes its mud-laden torrent down a deep canyon to the Green or Colorado Rivers.

At present, the country is populated with hundreds of miners and prospectors. Dozens of rough roads branch from the one main artery to little camps or sites where uranium mining is actively under way. Every cranny and rock ledge is being searched for signs of radioactivity. The Morrison formation appears in many places. Bedded deposits of uraninite and other ores occur in the Navajo, pre-Navajo, Shinarump, and other formations.

Near Hite, far down on the Colorado River, copper was mined many years ago. Uranium has been found in the same measures and today the copper is forgotten in the mining and recovery of the more valuable mineral. A new uranium-buying station is being located a few miles east of Hite. Glenny and Cutler, of Salt Lake City, are actively engaged in production of uranium near Hite. Several other groups are also opening up in other locations in the neighborhood. Congo Uranium is developing valuable properties in the Temple Mountain area.

Vernon Pick

The success story of Vernon Pick is as amazing as that of Charles Steen. Pick, an Eastern businessman was on his way to the West Coast with his family for a vacation. En route, he stopped at Grand Junction in Colorado and was intrigued with the mining excitement pervading the locality. He purchased a Geiger counter and started out for the region southwest of Greenriver, Utah. In the desolate sandblown area of the San Rafael Swell, his Geiger counter discovered ore of high radioactivity. He staked claims, filed his notices in the district mining offices, and returned to Grand Junction. Recent news releases state that the Pick holdings have been acquired by Atlas Corporation for $9,000,000, with Pick retaining an interest in the new organization.

For many years, Highway 666, turning northward at Gallup, New Mexico, meandering over the level Navajo land to Shiprock, New Mexico, and Cortez, Colorado, and zig-zagging over mesas and along canyons on Highway 160

EN ROUTE TO THE MILL: On the highway at Uraven, Colorado, heavy-duty trucks loaded with uranium ore are ready for the long haul to the mill at Rifle, Colorado.

MANY UNUSUAL FORMS: The erosive effects of the elements through the years have produced many strange forms, exemplified by this picture taken near the town of Bluff, Utah.

through Monticello and Moab, Utah, to Thompsons, on Highway 50, has constituted the one good road across the region. Occasional journeys to town by the Indians, cattlemen, or dry farmers did not justify much road improvement. The local folks made their own roads or used a trail, getting along with what they had. But, with the development of a rich industry within their borders and aided by funds from the Atomic Energy Commission, extensive road improvement programs have been started in the four states. More than 700 miles of access roads have been constructed at a cost of $4,500,000. Because of the nature of the terrain through which these roads must be built, it is sometimes difficult to distinguish an improved road from an unimproved one. During the current year, at least 175 more miles of improved roadways will be constructed with the aid of AEC funds.

High Taxes Limit Production

High taxes on profits accruing from uranium production are said to be limiting the output of many mines. Owner-operators often stop mining after production and profits reach a high taxing level, preferring to leave the ore in place as a reserve rather than to pay higher taxes on greater production. Unquestionably, some development programs are being undertaken with production limitations in mind.

Leasing is an attractive proposition for big and small operators, either from companies already working in the field or from the Government. Smaller investments are required when leasing from private corporations, and, generally, a smaller amount of development work is necessary because many of the claims have been acquired by these companies along the outcrops. The Government leases are usually in areas away from the outcrops, and shallow shafts are required. This, in turn, requires the construction of a headframe and the installation of a hoist and engine to operate it. However, Government leases offer a distinct advantage because of relatively complete exploration of the extent and thickness of the ore measure, and more accurate estimates of values which may be anticipated.

Lessors on mining claims are urged to seek competent legal counsel before completing such purchases, because many problems concerning taxes are involved in the transactions. Such pur-

(Continued on page 28)

MONOGRAM MESA: In a heavily timbered area on the north slope of Monogram Mesa, mine openings can be seen along the outcrop of the carnotite-bearing Morrison formation.

A TOAST TO THE PROSPECTOR

To you who have camped in the Yukon,
To you who have roamed on the Rand,
To the chap with a tan, to the type of a man
Who has patience, endurance, and sand;

To you who've gone down in the tropics
And to you who've mushed through the snow,
To you in the West, and to all of the rest,
No matter where you may go:

You have followed the magnetic needle,
You have trailed where the outcrop was thin,
You have shouldered your pack 'long the unbeaten track,
And in spite of it all you still grin.

From sunup to sundown you've wandered
In search of some fault plane or fold,
All of the time you've dreamed of a mine
Rich in copper and silver and gold.

Where the burro is used for a packsack,
And the desert sun burns like a flame
And the water you drink makes a man stop and think
That mining's a Hell of a game.

Of course there's the lure of a fortune –
The city, its bright lights and all –
But it's true, just the same, that the thrill of the game
Makes you answer the prospector's call.

So, here's to you, prospector-miner –
In a toast you'll join in, I know –
Here's to Hanging and Foot, may they always stay put,
Never meet – bottoms up! here's a go!

BY EDWARD THOMPSON

MAKEREADY: Two welded Monel cylinders are telescoped and placed in a heavy laminated steel die. The assembly is partially filled with water and a dynamite cartridge is suspended at water level. The heavy block at left is placed over the die.

Dynamite Cuts the Cost of Air

Dynamite helps to form the hubs of fans used in industry

DYNAMITE plays an important part in forming the hubs of huge industrial fans manufactured by The Moore Company of Marceline, Missouri. The blasting-with-dynamite fabrication method was developed some years ago, and the economies effected have been so significant that the company is able to sell fans made of Monel at prices only slightly higher than fans made of noncorrosion resistant metals.

The Moore method involves the telescoping of two welded Monel cylinders into each other, after which the unit is placed in a heavy laminated steel die. The assembly is partially filled with water and one cartridge of dynamite is suspended at water level. A heavy block is then placed over the die and the dynamite cartridge is detonated. The resulting explosion forces the cylinders into the contours of the die in a single operation.

The cost of the simplified shaping operation, made possible with dynamite, is considerably lower than the cost of spinning, and, at the same time, it completely eliminates any waste metal and loss of time for annealing.

"FIRE": The dynamite cartridge is detonated and the cylinders are forced into the contours of the die in one quick, economical operation.

THE HUB: When the hub is removed from the die, it looks like the above illustration. Although seemingly farfetched, dynamite plays an important part in the fabrication of the huge fans.

MINING URANIUM

(Continued from page 25)

chases take one of several forms which can materially affect the profits of an organization. These forms include outright sales, bond and lease, down payment with royalty of a specified amount, or a down payment with a monthly or annual royalty dependent on production.

Persons unacquainted with the different forms of business organizations are also advised to discuss in detail matters of new organizations with competent counsel before developing their corporate forms of organization. In many instances, workable partnerships are more desirable than an incorporated setup.

Amazing Changes

Today, modernity has come to this wild, bewildering area in a very amazing way. Instead of a lone horseman on a dusty trail or a prospector hazing a burro loaded with camp supplies, a jeep will speed by or a truck laden with rich ore will roll out of a rocky canyon side road on its way to the mills. Cattle still range the hills and sheep are often seen. Farmers continue to raise beans and hay and a few people fail to become excited by the orgy of prospecting and mining that has hit the region.

The small towns are growing rapidly. Crude adobe shelters and Navajo hogans will continue to be seen in the years ahead, but the new homes springing up still carry in their design the Spanish motif of the early-day explorers and settlers of the Southwest. High-priced automobiles are found parked beside prospect holes or on lonely ridges, with their owners miles away, exploring, testing, or digging for that metal which has become so precious in the minds of men and nations throughout the world.

With the remarkable advances made in nuclear science in the past five years, it is impossible to evaluate how much the uranium industry will affect the lives and destinies of individuals as well as of nations in the next decade. Directed toward peaceful uses, it can conceivably revolutionize every phase of industry and of human existence. The favorable potentials of uranium for peacetime uses are inexhaustible; its possibilities for waging warfare are terrible and terrifying.

THE FOUR CORNERS: The photographer took a picture of the author, Charles F. Thomas, while seated on a marker at the corner common to the four states — Utah, Colorado, New Mexico, and Arizona. The rocks form letters to designate the four states.

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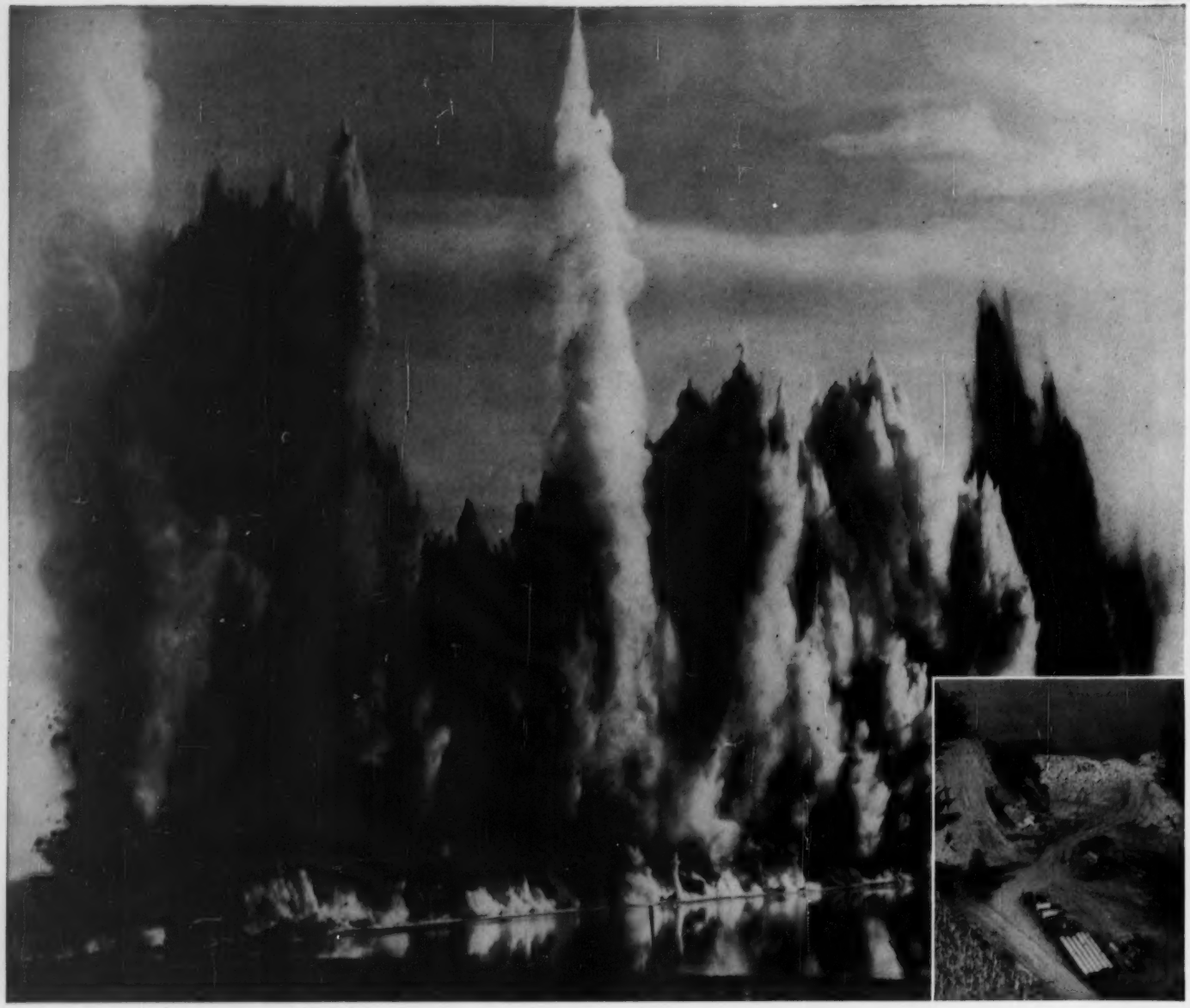

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